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A CLASSIFICATION OF FOREST ENVIRONMENTS IN THE SOUTH UMPQUA BASIN

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ABSTRACT

Forest environments are classified by elevation, temperature, moisture, potential solar radiation, and soil type. Broad elevation classes are derived from topographic maps or altimeter measurements, measured temperature and moisture conditions are related to vegetation by using plant indicator species (illustrated), and tabular values are employed in estimating potential solar radiation. A series key is included for identifying soil types. Future correlations of silvicultural practices with environmental classes will facilitate optimal prescription for each forest environment in the basin.

Keywords: Classification, environment, indicator plants, temperature, moisture, solar radiation, soil series.

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CONTENTS

INTRODUCTION

Land management techniques are numerous and well known, but knowledge of where and how to use these techniques often is inadequate. The silvicultural methods used by foresters in the Pacific Northwest exemplify this predicament. Silviculture largely consists of applying standard techniques to various forest stands. Unfortunately, silvicultural techniques are not universally applicable. They should be selected and modified to fit the environment of each individual forest stand. For example, clearcutting and planting produce healthy young forests in some environments but result in nonstocked brushfields in others. The techniques of wildlife management, recreation, and judicious wilderness use, like those of silviculture, should be tailored to fit the environments in which they are applied. Classification of forest environments and development of management practices for each environmental class will result in greatly improved forest land management.

Environments are not easily classified. Many interacting factors combine to produce any environment. Measuring all of these directly is impractical, even in a simple environment. For example, Penman (1965) recorded solar radiation, temperature, humidity, precipitation, soil moisture, wind velocity, and carbon dioxide in a barley field. The resulting data were expensive to obtain and difficult to integrate meaningfully. Furthermore, they were relevant to only a small field on a single summer day. Measuring all of the environmental factors in a large, complex area like the South Umpqua basin would be infeasible. Indirect measurements of site capacity (Rennie 1963) or the environmental complex as a whole are more practicable.

Among the simplest indirect measurements of site capacity are the site indexes of commercial tree species--where local site index curves are available for the area being evaluated (Jones 1969). Unfortunately, local site index curves are not available for the South Umpqua basin, and the curves constructed from trees measured in northwestern Oregon and Washington probably do not accurately portray South Umpqua growth patterns. Furthermore, site indexes furnish little environmental information when used alone. A site index may be low for several reasons. These reasons may not be the same in different environments and may or may not limit various land management techniques. Site index should be combined with other environmental information. For example, Hayes and Hallin (1962) rated the South Umpqua area for Douglas-fir, ponderosa pine, and sugar pine by using site indexes and elevation.

Classification of the vegetation into "communities" or "associations" delineated by measurements or estimates of plant composition, coverage, density, dominance, frequency, fidelity, etc., often is a useful way of comparing environments. If not carefully used, however, these community classifications tend to relate vegetation to vegetation rather than vegetation to environment. Moreover, vegetation is subject to historical influences in addition to environmental influences, and community classification is best done in undisturbed, stable areas--preferably by a community ecologist. The South Umpqua basin is a disturbed, unstable area, and most land managers are not community ecologists. Therefore, community classification is not employed in this environmental classification.

Fortunately, plants respond as individuals to the environments in which they live, and they may be used as environmental indicators without recourse to community classification (Gleason 1939, Goodall 1963). Rowe (1956) recommended using the presence or absence of plant species as easily interpreted indicators of environmental factors. Ideally, the environmental factors should be measured independently, then related to species' presence. Pluth and Arneman (1965) attempted this in Minnesota but used the botanical literature as their "measurements" and seem to have obtained

their results through a process of circular reasoning. Griffin (1967) actually measured one environmental factor (soil moisture) and related his indicator species to it. Several environmental factors were measured and related to species' presence by Waring and Major (1964) and by Waring (1969).

This classification of forest environments in the South Umpqua basin is based upon species' presence and the measurement or estimation of four environmental factors that are basic to plant growth: temperature, moisture, solar radiation, and soil type. It is applicable in that portion of the basin bounded on the west by North Myrtle, Canyon, and Starveout Creeks; on the south and east by the South Umpqua-Rogue divide; and on the north by the South Umpqua-Little River divide (fig. 1).

The classification presented here is a first step--a tool to be used in further work. Silvicultural prescriptions must be developed for each environment. This will be done by classifying environments before silvicultural treatment, recording success or failure of the treatment, then applying this information to all areas in the same environmental class. Eventually, a catalog of successful and unsuccessful treatments will be available for each environmental class in the South Umpqua basin.

METHODS

Fifty plots were established in the study area. Each plot consisted of a one-fifth-acre circle centered on one or more 6-foot conifer seedlings. All plots were in mature forest. All supported conifer regeneration, and none included topographic irregularities (gullies, ridge tops, slope changes, etc.). Forest type and understory vegetation were not considered, but the plots were carefully chosen to secure several plots on each aspect at elevations between 900 and 5,500 feet They were scattered throughout the study area, serving as references for measurements and observations and for comparisons of ecological parameters, plant species, and soils. One plot was logged before observation or measurement, so this classification of environments is based upon 49 plots.

The route to each plot and the plots themselves were plainly marked with plastic flagging to facilitate plot locations on dark nights. Elevations were determined with an altimeter calibrated against known bench marks, and aspects were determined with a compass. Slope percents were measured with an Abney hand level.

Summer soil temperature at 8 inches can be used as an index of environmental

Figure 1.—The study area. Circles locate plots.

temperature (Shanks 1956). Soil temperatures were measured on 25 plots representative of all elevations and aspects. Maximum-minimum thermometer bulbs were buried 8 inches deep in covered pits during July 1970 and allowed to equilibrate for 2 weeks. The maximum and minimum soil temperatures recorded during August and September were then used to obtain a median soil temperature for each of the 25 plots. Animals and vandals damaged two of these plots, leaving 23 for measured temperature comparisons.

It should be emphasized that the median soil temperatures measured at 8 inches are crude measurements of summer temperatures. They do not indicate important differences in length of the growing season. Elevation was used as an independent, indirect indicator of growing season length.

Moisture conditions on each plot were measured by using the pressure bomb technique described by Waring and Cleary (1967). Between 10:00 p.m. and dawn, three or more twigs were clipped from each of the 6-foot conifer seedlings on each plot. Plant moisture stresses were immediately determined in each cut twig by measuring the gas pressure required to extrude sap from the cut end of the twig when its needles were gradually pressurized in the pressure bomb chamber. Sizable variations occasionally occurred on the same plot. These variations seemed to be caused by branch injuries or unhealthy conifer seedlings. (An injured branch or dying seedling is under high moisture stress even when it is growing in moist conditions.) Accordingly, the lowest moisture stress recorded on a plot at any given nocturnal visit was considered to be the best estimate of plant moisture stress at that time. When moisture stresses were measured first between 10:00 p.m. and midnight and then again just before dawn on the same plots, 2-atmosphere drops in plant moisture stresses were observed. Since it was physically impossible to visit all 49 plots just before dawn, even though the minimum moisture stress measured just before dawn best reflects soil moisture conditions, 2 atmospheres were subtracted from moisture stresses measured between 10:00 p.m. and midnight. One atmosphere was subtracted from moisture stresses measured between midnight and 2:00 a.m. No adjustments were made for moisture stresses measured after 2:00 a.m.

As moisture stress data accumulated, differences between conifer species became evident. Wherever grand fir and Douglas-fir seedlings occurred together, grand fir was under lower moisture stress. Since neither grand fir nor Douglas-fir seedlings occurred on all 49 plots, moisture stresses in 59 pairs of side-by-side grand fir and Douglas-fir seedlings were measured throughout the South Umpqua basin to compare moisture stresses in these species. A regression was calculated from the resulting data. All final moisture stress values were expressed in terms of grand fir moisture stress, using grand fir measurements where available and the regression wherever only Douglas-fir occurred. The grand fir moisture stresses, expressed in atmospheres, were used as indexes of moisture conditions on the plots.

Nocturnal moisture stresses were measured on every plot during the weeks of July 20, August 3, August 18, and September 8, 1969, until the autumn rains. The September moisture stresses were higher than those measured earlier in the season; they represented the peak of summer drought in 1969 and were subsequently used in all moisture comparisons.

Potential solar radiation was estimated for each plot by using measured slope and aspect to obtain a radiation index from the tables of Frank and Lee (1966). Table 1 lists these indexes for the South Umpqua area.

Soils were examined by digging a 3-foot pit on each plot during the spring of 1970. The soil profile was diagramed in each pit, and color, texture, density, stoniness, and pH were recorded for each horizon. Depth to bedrock, parent material, and rooting depth were also recorded wherever possible.

Plants growing on the plots were collected and identified weekly from April 1 to June 20, then biweekly from June 20 until September 1969. All vascular plant

Table 1.–Radiation indexes for the South Umpqua area, by aspect and slope[1]

Aspect	Percent slope										
	0	10	20	30	40	50	60	70	80	90	100
N.	0.465	0.426	0.386	0.345	0.306	0.272	0.244	0.219	0.198	0.179	0.163
S.	.465	.498	.527	.551	.569	.582	.591	.596	.599	.599	.597
NNE.-NNW.	.465	.429	.387	.355	.320	.288	.260	.237	.217	.199	.184
SSE.-SSW.	.465	.496	.523	.545	.562	.574	.582	.587	.589	.589	.588
NE.-NW.	.465	.438	.410	.383	.357	.334	.313	.295	.279	.266	.255
SE.-SW.	.465	.488	.509	.527	.540	.549	.556	.559	.560	.560	.558
ENE.-WNW.	.465	.450	.435	.421	.407	.395	.383	.373	.364	.355	.348
ESE.-WSW.	.465	.477	.489	.498	.505	.509	.512	.512	.511	.510	.507
E.-W.	.465	.464	.463	.461	.459	.456	.452	.449	.444	.440	.435

1/ Calculated for lat. 43° N. from the tables of Frank and Lee (1966).

species present were identified.1/ The species lists obtained from the 49 plots were compared with plot temperature and moisture data to estimate temperature and moisture ranges for every plant species. Those species with limited or characteristic ranges were used as indicators. The indicator species were weighted by assigning them point values in a procedure similar to that used by Rowe (1956). Those typical of warm or wet environments were weighted heavily. Those typical of cold or dry environments were weighted lightly. Point values used are as follows:

Temperature	Moisture
12 (hot)	15 (wet)
8	10
4	5
1 (cold)	1 (dry)

A plant temperature index for each plot was calculated by averaging the point values of all indicator species present on the plot. A plant moisture index was calculated similarly.

[1] *Taxonomists at the U.S. Forest Service Herbarium, Washington, D.C., identified many of the plants.*

RESULTS

ELEVATION

Plot elevations ranged from 910 feet to 5,440 feet. They were divided into three groups for classification purposes:

Elevation	Elevation class
Below 2,500 feet	Low elevation
2,500 to 4,000 feet	Middle elevation
Above 4,000 feet	High elevation

Of the 49 plots, 18 were at low elevations, 15 at middle elevations, and 16 at high elevations (table 2).

TEMPERATURE

Median summer soil temperatures at a depth of 8 inches ranged from a low of 48.0° F. recorded at an elevation of 5,180 feet to a high of 60.5° F. recorded at 2,220 feet (table 2). Aspect apparently was less important than elevation and cold air drainage in determining summer temperature, for both of these temperatures were recorded on southern aspects. Cold air drainage seemed to be particularly influential in determining summer soil temperatures.

Table 2.–Plot elevations, temperatures, moisture, aspects, slopes, radiation indexes, and soil series

Elevation class and plot elevation	Median soil temperature	Estimated temperature class[1/]	Plant moisture stress	Estimated moisture class[1/]	Aspect	Slope	Radiation index	Radiation class	Soil series
Feet	*° F.*		*Atmospheres*			*Percent*			
Low:									
1,520	60.0	Hot	19.3	Very dry	SE.	25	.509	Moderate	Prong
1,590	58.0	Hot	15.0	Dry	SSE.	80	.589	High	Coyote
1,460	59.5	Hot	13.5	Dry	WNW.	40	.407	Low	Prong
2,220	60.5	Hot	11.3	Moist	S.	30	.551	High	Freezeout
910	57.5	Warm	20.9	Very dry	NE.	85	.266	Low	Prong
2,430	55.5	Warm	17.1	Very dry	WNW.	50	.395	Low	Straight
1,720	--	Warm	15.0	Dry	S.	20	.527	High	Boze
1,890	56.5	Warm	13.6	Dry	SSW.	50	.574	High	Freezeout
2,160	--	Warm	14.5	Dry	SW.	40	.540	High	Bullock
1,750	--	Warm	14.1	Dry	ENE.	20	.435	Moderate	Tallow
2,280	--	Warm	8.2	Dry	ESE.	30	.498	Moderate	Fivesticks
1,300	56.5	Warm	7.0	Moist	S.	60	.591	High	Crater Lake
2,440	--	Warm	9.3	Moist	SSE.	20	.523	High	Dumont
2,060	55.5	Warm	6.0	Moist	SW.	10	.488	Moderate	Acker
1,650	--	Cool	3.3	Moist	Level	0	.465	Moderate	Alluvium
1,730	--	Cool	3.3	Moist	Level	0	.465	Moderate	Alluvium
2,210	--	Cool	4.7	Moist	WNW.	20	.435	Moderate	Prong
2,080	55.5	Cool	9.3	Moist	NE.	30	.383	Low	Acker
Middle:									
3,100	59.0	Hot	14.1	Dry	S.	35	.551	High	Prong
3,050	--	Warm	9.9	Dry	SW.	40	.540	High	Acker
3,140	--	Warm	8.7	Dry	SW.	45	.540	High	Deadman
2,870	--	Warm	12.3	Dry	N.	15	.426	Moderate	Bullock
3,080	--	Warm	14.7	Dry	SE.	20	.509	Moderate	Zinc
3,180	--	Warm	15.5	Dry	WSW.	40	.505	Moderate	Boze
2,660	56.0	Warm	8.3	Dry	ENE.	60	.383	Low	Acker
2,950	--	Warm	11.3	Moist	ESE.	30	.498	Moderate	Vena
2,620	56.5	Warm	4.7	Moist	ENE.	70	.373	Low	Straight
2,690	57.0	Cool	12.2	Dry	SSE.	40	.562	High	Deadman
3,390	--	Cool	4.7	Moist	ENE.	20	.435	Moderate	Acker
3,660	--	Cool	4.3	Moist	SW.	20	.509	Moderate	Boze
3,670	54.0	Cool	4.0	Moist	SE.	50	.549	High	Vena
3,860	54.0	Cool	4.3	Moist	NNW.	35	.355	Low	Prong
3,990	54.0	Cold	5.0	Moist	E.	40	.459	Moderate	Freezeout
High:									
4,100	--	Warm	9.9	Moist	SW.	40	.540	High	Bullock
4,040	54.5	Cool	6.7	Moist	SSE.	30	.545	High	Gustin
4,180	--	Cool	4.3	Moist	S.	20	.527	High	Acker
4,550	--	Cold	3.3	Moist	SSW.	25	.545	High	Prong
4,820	--	Cold	6.0	Moist	SW.	55	.549	High	Snowbird
4,870	53.0	Cold	3.7	Moist	SSW.	35	.545	High	Snowbird
5,260	--	Cold	5.7	Moist	SE.	30	.527	High	Vena
4,330	--	Cold	4.7	Moist	SE.	35	.527	High	Prong
4,070	--	Cold	8.3	Moist	ESE.	55	.509	Moderate	Prong
4,190	--	Cold	5.3	Moist	N.	15	.426	Moderate	Vena
5,180	48.0	Cold	4.7	Moist	SSE.	5	.465	Moderate	Freezeout
5,240	--	Cold	4.7	Moist	NW.	10	.438	Moderate	Prong
4,500	51.5	Cold	6.0	Moist	ENE.	50	.395	Low	Prong
4,300	51.1	Cold	8.0	Moist	ENE.	65	.373	Low	Hummingbird
5,060	--	Cold	2.7	Moist	NE.	20	.410	Low	Acker
5,440	50.0	Cold	5.0	Moist	NE.	25	.410	Low	Vena

1/ Estimates based upon presence of indicator plants.

Plant indicator species found to be useful in estimating summer soil temperatures are listed in table 3. When the plant temperature indexes calculated by using these indicator species were plotted against the measured soil temperatures for each of the 23 temperature plots (fig. 2), the correlation was highly significant (r = 0.94).

Table 3.–Species and point values used in calculating plant temperature indexes

Species[1/]	Point value	Species[1/]	Point value
Abies magnifica Murr. var. *shastensis* Lemm.	1	*Ligusticum apiifolium* (Nutt.) Gray	4
Actaea rubra (Ait.) Willd.	1	*Lonicera hispidula* Dougl.	12
Anemone deltoidea Hook.	4	*Montia sibirica* (L.) How.	4
Arbutus menziesii Pursh	8	*Pachystima myrsinites* (Pursh) Raf.	4
Arctostaphylos canescens Eastw.	4	*Pinus ponderosa* Dougl.	4
Arnica cordifolia Hook.	4	*Pyrola picta* J. E. Sm.	4
Berberis aquifolium Pursh	12	*Quercus chrysolepis* Liebm.	8
Cornus nuttallii Aud.	4	*Quercus kelloggii* Newb.	8
Cynoglossum grande Lehm.	8	*Rhus diversiloba* T. & G.	12
Disporum hookeri (Torr.) Britt.	4	*Satureja douglasii* (Benth.) Brig.	12
Festuca californica Vas.	8	*Taxus brevifolia* Nutt.	4
Galium oreganum Britt.	1	*Thuja plicata* D. Don	4
Gaultheria shallon Pursh	12	*Tiarella unifoliata* Hook.	1
Goodyera oblongifolia Raf.	4	*Tsuga heterophylla* (Raf.) Sarg.	4
Habenaria unalascensis (Spreng.) Wats.	4	*Valeriana sitchensis* Bong.	1
		Xerophyllum tenax (Pursh) Nutt.	4

[1/] Nomenclature follows Hitchcock et al. (1955-69) and Peck (1961).

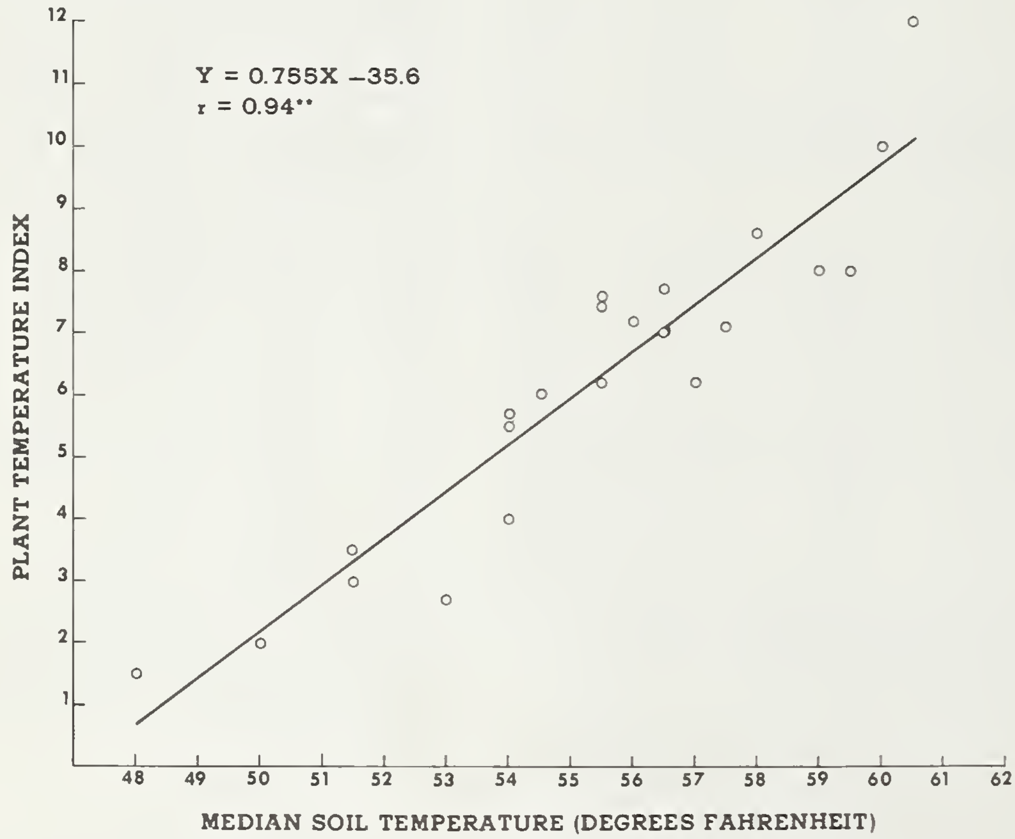

Figure 2.—Correlation of median August-September soil temperature at 8 inches and plant temperature index.

To facilitate classification, the range in plant temperature indexes was divided into four groups:

Plant temperature index	Temperature class
8.0 and above	Hot
6.5 to 7.9	Warm
4.1 to 6.4	Cool
4.0 and below	Cold

Five of the 49 plots were classified "hot," 19 were "warm," 11 were "cool," and 14 were "cold."

MOISTURE

The moisture stress regression for grand fir-Douglas-fir is shown in figure 3. All plant moisture stresses were measured in pounds per square inch, expressed in terms of grand fir stress, and converted to atmospheres (1 atmosphere equals 14.7 pounds per square inch). The nocturnal plant moisture stresses measured in September 1969 ranged from a low of 2.7 atmospheres to a high of 20.9 atmospheres (table 2). Plant indicator species found to be useful in estimating moisture stress are listed in table 4. When the plant moisture indexes calculated by using these indicator species were plotted against the measured moisture stresses on each plot (fig. 4), the correlation was highly significant (r = 0.90).

The range in plant moisture indexes was divided into three groups:

Plant moisture index	Moisture class
Above 8.0	Moist
4.0 to 8.0	Dry
Below 4.0	Very dry

Of the 49 plots, 31 were classified "moist," 15 were "dry," and only three were "very dry."

POTENTIAL SOLAR RADIATION

Calculated radiation indexes on the 49 plots ranged from 0.266 (85-percent slope on a NE. aspect) to 0.591 (60-percent slope on a S. aspect). This range in potential solar radiation was divided into three groups:

Radiation index	Radiation class
Below 0.420	Low
0.420 to 0.520	Moderate
Above 0.520	High

Table 4.–Species and point values used in calculating plant moisture indexes

Species[1/]	Point value	Species[1/]	Point value
Adenocaulon bicolor Hook.	10	*Gaultheria shallon* Pursh	10
Amelanchier alnifolia var. *humptulipensis* (G. H. Jones) C. L. Hitchc.	10	*Lonicera hispidula* Dougl.	1
Anemone deltoidea Hook.	15	*Osmorhiza chilensis* (Hook.) Arn.	10
Arctostaphylos canescens Eastw.	10	*Pinus ponderosa* Dougl.	5
Arnica cordifolia Hook.	10	*Psoralea physodes* Hook.	10
Berberis aquifolium Pursh	5	*Pyrola picta* J. E. Sm.	10
Berberis nervosa Pursh	10	*Rhododendron macrophyllum* G. Don	15
Castanopsis chrysophylla (Dougl.) A. DC.	10	*Rhus diversiloba* T. & G.	1
Ceanothus integerrimus H. & A.	10	*Rubus nivalis* Dougl.	15
Clintonia uniflora (Schult.) Kunth	15	*Smilacina stellata* (L.) Desf.	15
Corallorhiza maculata Raf.	10	*Thuja plicata* D. Don	15
Cornus nuttallii Aud.	10	*Tsuga heterophylla* (Raf.) Sarg.	15
Festuca californica Vasey	5	*Vaccinium parvifolium* J. E. Sm.	10

[1/] Nomenclature follows Hitchcock et al. (1955-69) and Peck (1961).

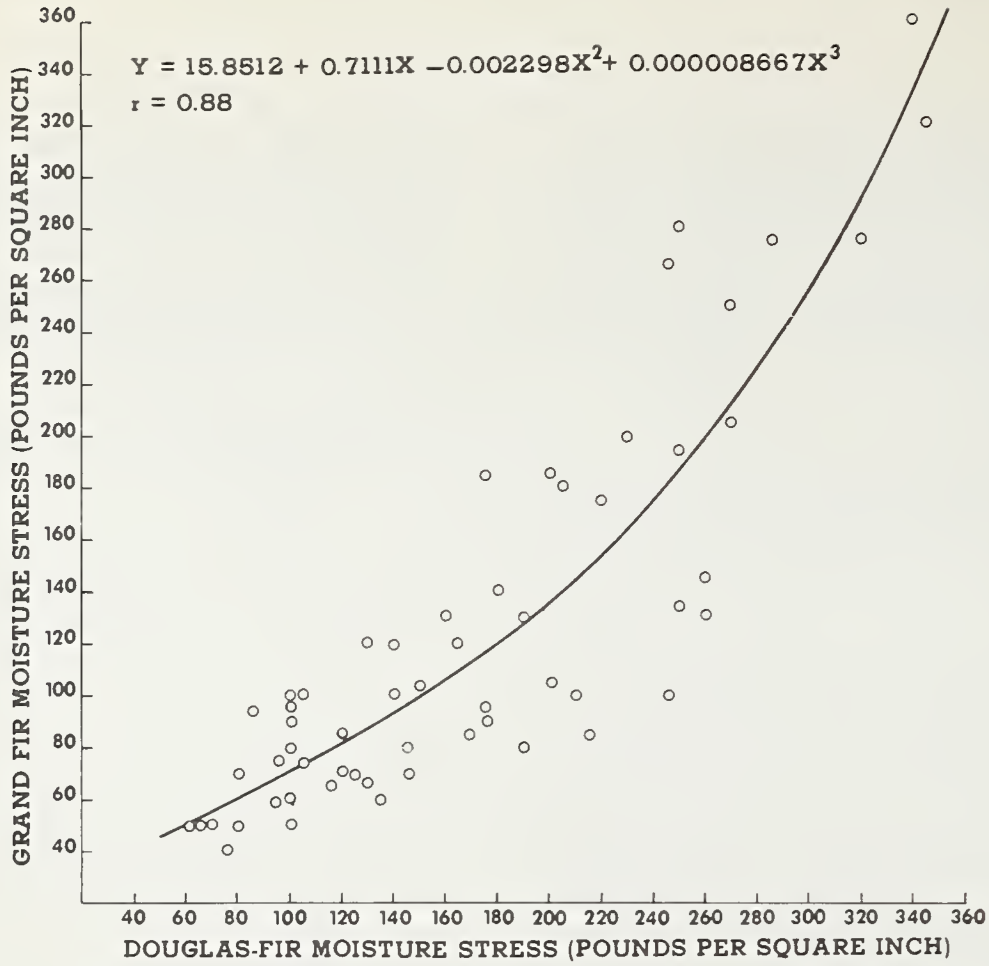

Figure 3.—Moisture stress regression for grand fir-Douglas-fir.

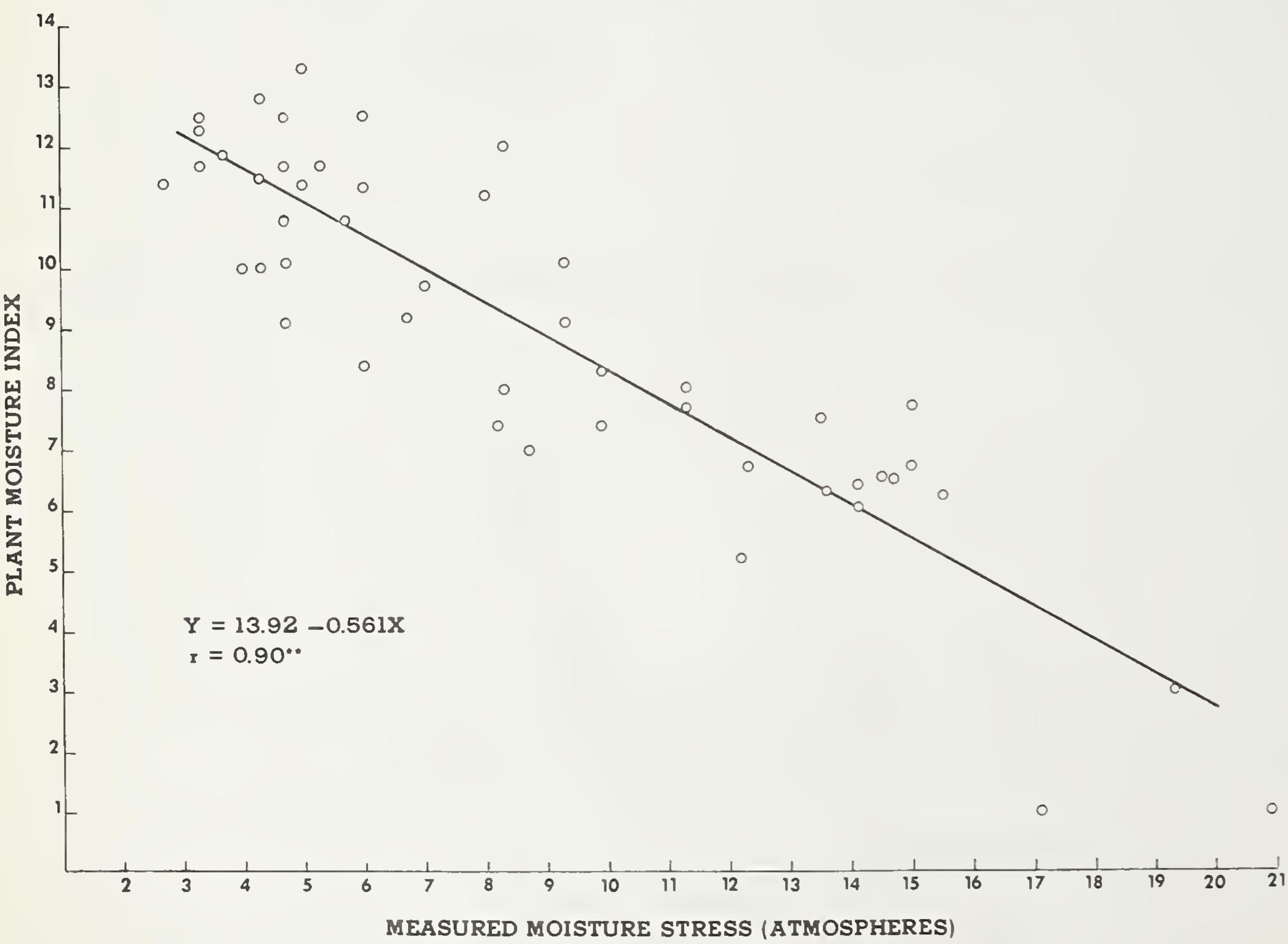

Figure 4.—Correlation of measured moisture stress and plant moisture index.

Eleven plots were classified "low radiation," 18 were "moderate radiation," and 20 were "high radiation" environments.

SOILS

Profile diagrams and descriptions differed from plot to plot, but no single soil measurement or observation was deemed reliable enough to be useful in comparing the wide variety of soils found in the South Umpqua basin. The soil profile description for each plot was therefore compared with the soil series descriptions included in the South Umpqua Soil Survey.[2] Unfortunately, this soil survey covered only part of the study area--that part north and east of Jackson Creek. Nevertheless, the soil survey series descriptions matched plot soil profile descriptions well enough to permit tentative classification of the soils on all 49 plots into named soil series.

Since complete soil series descriptions are rather long and often not readily available, a simplified soil series key was constructed from soil survey series descriptions and field observations of the plot soils. This soils key (appendix IV) includes 18 series. No claim is made to absolute accuracy, and unerring soil series identification is not guaranteed when the key is used. Nevertheless, it is a simple, usable field key that should permit field classification of South Umpqua soils into easily recognizable, comparable categories.

DISCUSSION

Five environmental factors were classified in the South Umpqua basin: elevation (three classes), temperature (four classes), moisture (three classes), potential solar radiation (three classes), and soil (18 series). If all classes for all five factors are considered, in all possible combinations, almost 2,000 environmental categories are possible. A simple ordering of classification categories is essential if meaningful area comparisons are to be accomplished.

Elevation, temperature, and moisture should be considered first when classifying and comparing environments. Elevation is easily obtained from a topographic map. Temperature and moisture classes can be quickly determined in the field by using indicator plants to calculate temperature and moisture indexes. In many instances, no further classification will be necessary. For example, similarities and differences between a low-elevation, warm, moist environment and a low-elevation, hot, dry environment will be obvious.

If more information is desired, potential solar radiation and soil series may be determined. A low-elevation, warm, moist, high-radiation environment with Bullock soil certainly differs from a low-elevation, warm, moist, moderate-radiation environment with Acker soil. For some purposes, the radiation and soil differences may not be important; for others, they may be essential.

Descriptive phrases seem to constitute the best environmental labels. Elevation (low, middle, or high), temperature (cold, cool, warm, or hot), moisture (moist, dry, or very dry), solar radiation (low, moderate, or high), and soil (series name) should be stated in that order. For example, the environments of two plots listed in table 2 are described as follows:

First plot = low-elevation, hot, very dry, moderate-radiation environment with Prong soil
Last plot = high-elevation, cold, moist, low-radiation environment with Vena soil

Abbreviations may be used where space is limited, as on maps:

First plot = L, Ht, Vd, m - Pr
Last plot = H, Cd, Mt, l - Ve.

The information required to relate this environmental classification to land management techniques will not be available until the techniques are used and evaluated in classified environments. However, some productivity relationships are already apparent. Douglas-fir site trees were measured on 44 of the 49 plots, and site classes were approximated by using McArdle and Meyer's (1930) site curves.

[2] *USDA Forest Service unpublished inservice report, 1961.*

These curves for northwestern Oregon and Washington probably do not accurately portray South Umpqua growth patterns, but no better ones are available. When the approximate site classes were compared with environmental data, the following relationships were evident:

1. The Acker, Alluvium, Coyote, and Freezeout series are good Douglas-fir soils.

2. The Bullock, Fivesticks, Gustin, Tallow, and Zinc series are poor Douglas-fir soils. As Stephens (1965) observed, ponderosa pine grows better than Douglas-fir on soils like these which have clay subsoils.

3. Cool, moist environments are good Douglas-fir sites wherever deep, nonsticky soils occur.

4. Environments with plant temperature indexes below 2.5 or with plant moisture indexes below 7.0 are poor Douglas-fir sites.

Several plant species were found to be useful indicators of Douglas-fir site (table 5). When the indexes calculated by using these indicator species were plotted against McArdle-Meyer site indexes on each plot (fig. 5), the correlation was highly significant (r = 0.87).

Table 5.–Species and point values used in calculating plant site indexes

Species[1]	Point value	Species[1]	Point value
Abies magnifica Murr. var. *shastensis* Lemm.	1	*Montia sibirica* (L.) How.	10
Acer circinatum Pursh	10	*Oxalis* sp.	10
Arctostaphylos canescens Eastw.	1	*Pachystima myrsinites* (Pursh) Raf.	1
Arctostaphylos nevadensis Gray	1	*Pinus ponderosa* Dougl.	1
Asarum hartwegii Wats.	10	*Quercus chrysolepis* Liebm.	1
Berberis aquifolium Pursh	1	*Quercus garryana* Dougl.	1
Campanula scouleri Hook.	10	*Rhus diversiloba* T. & G.	1
Castanopsis chrysophylla (Dougl.) A. DC.	5	*Rubus nivalis* Dougl.	1
Ceanothus integerrimus H. & A.	10	*Salix* sp.	1
Cynoglossum grande Lehm.	5	*Smilacina racemosa* (L.) Desf.	1
Disporum hookeri (Torr.) Britt.	5	*Smilacina stellata* (L.) Desf.	10
Festuca californica Vasey	5	*Taxus brevifolia* Nutt.	1
Galium oreganum Britt.	1	*Thuja plicata* D. Don	10
Ligusticum apiifolium (Nutt.) Gray	1	*Trillium ovatum* Pursh	10
		Tsuga heterophylla (Raf.) Sarg.	5
		Vaccinium membranaceum Dougl.	10

[1] Nomenclature follows Hitchcock et al. (1955-69) and Peck (1961).

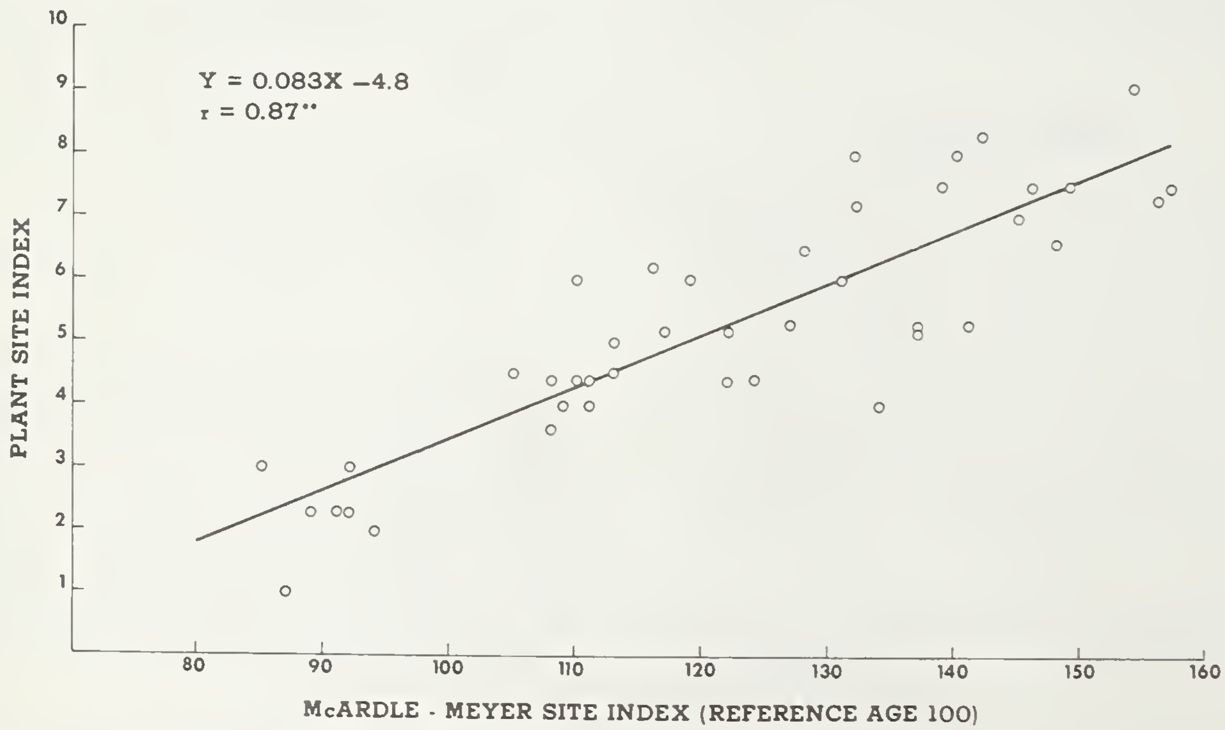

Figure 5.—Correlation of McArdle-Meyer site index and plant site index.

Photographs of the indicator plants and an outline of classification procedure are included in the appendixes. These appendixes have one primary purpose--field use. If used in the field, the procedure outlined on these pages should provide comparisons that will eventually make it possible to categorize environments in terms of specific land management techniques.

Users are cautioned that this classification is applicable only to mature stands in the study area. It is not appropriate for recently logged stands and should not be used outside the South Umpqua basin.

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APPENDIX I

INDICATOR PLANT SPECIES

Most land managers are familiar with the following indicator plants. They have not been photographed.

Abies magnifica var. *shastensis* (Shasta red fir)

Acer circinatum (vine maple)

Arbutus menziesii (madrone)

Castanopsis chrysophylla (chinquapin)

Cornus nuttallii (western flowering dogwood)

Gaultheria shallon (salal)

Pinus ponderosa (ponderosa pine)

Rhododendron macrophyllum (western rhododendron)

Rhus diversiloba (poison oak)

Salix sp. (willow)

Taxus brevifolia (western yew)

Thuja plicata (western redcedar)

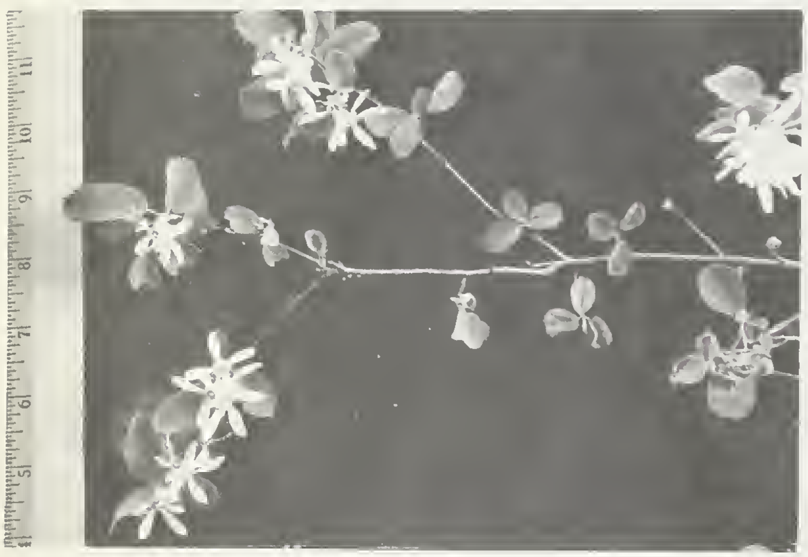
Tsuga heterophylla (western hemlock)

Xerophyllum tenax (beargrass)

Another, less familiar, indicator plant was not photographed: *Festuca californica* (California fescue) is a large grass. Its 3- to 5-foot-tall flowering stems grow in clusters and bear few leaves. They support loose, open, drooping groups of short-awned flowers. The densely clumped basal leaves are stiff and rough, often fold inward upon themselves.

Actaea rubra (western baneberry).—Compound leaves are in groups of three. The leaflets are tipped with tiny, blunt spines. Flowers are white, berries red.

Adenocaulon bicolor (trail plant).—Leaves are dark green and smooth above, silvery and white-woolly below. Flowers are small, white, and inconspicuous.



Amelanchier alnifolia (western serviceberry).—A large shrub or small tree. The thin leaves are simple, with sharply toothed apical halves. Flowers are white, berries purple.

Anemone deltoidea (western white anemone).—Basal leaves are trifoliate, with toothed or incised margins. Stem leaves are borne in a whorl below the large white flower.

Arctostaphylos canescens (hoary manzanita).—An upright shrub with smooth, wine-red bark. Leaves are gray-green and finely gray-woolly, with short-toothed tips. Flowers are white or pink.

Arctostaphylos nevadensis (pine mat manzanita).—A prostrate shrub. Leaves are bright green with short-toothed tips. Flowers are white or pink.

Arnica cordifolia (heart-leaved arnica).—The large leaves are opposite and broad, borne in pairs on the flowering stem. The daisy-like flower is yellow.

Asarum hartwegii (marbled wild ginger).—Large leaves are conspicuously white-mottled or marbled above. Flowers are brownish purple, inconspicuous, borne very near the ground.

Berberis aquifolium (Oregon grape).—Compound leaves are glossy above, with only five to seven leaflets. Flowers are yellow, berries deep blue.

Berberis nervosa (long-leaved Oregon grape).—Compound leaves are dull above, with nine to 15 leaflets. Flowers are yellow, berries deep blue.

Campanula scouleri (Scouler's harebell).—Leaves and stems have milky juice. Flowers are pale blue or white.

Ceanothus integerrimus (deerbrush).—An upright shrub with slender, flexible twigs. The small, smooth-margined, alternate leaves usually are three-veined at the base. Flowers are white or blue.

Clintonia uniflora (queencup).—Leaves are flat and thin, with parallel veins and slightly hairy margins. The flower is white, the berry deep blue.

Corallorhiza maculata (spotted coral-root).—The brownish-purple stem is leafless. Orchidlike flowers have white lips that are mottled with dark red.

Cynoglossum grande (great hounds-tongue).—The large, alternate leaves are woolly below, with long petioles. Flowers are blue and white.

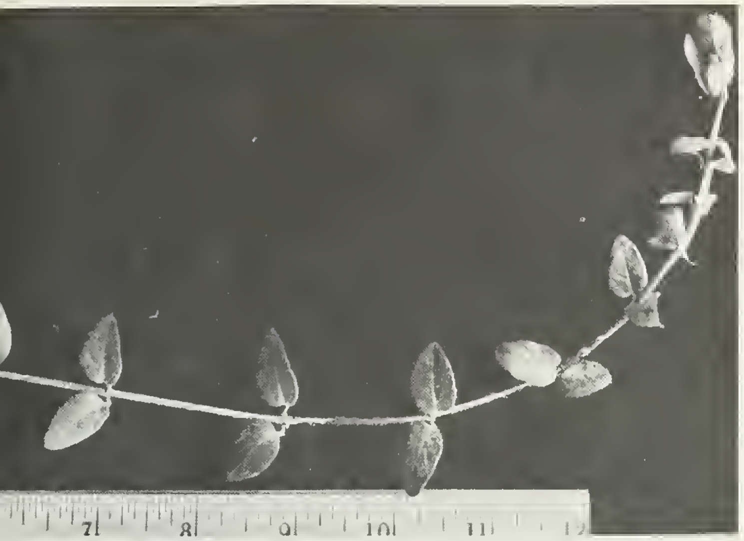
Disporum hookeri (Hooker's fairybells).—Alternate, sessile leaves are borne on a branched stem. Flowers are greenish white, berries red.

Galium oreganum (Oregon bedstraw).—Conspicuously three-veined leaves are borne in whorls of four. Flowers are tiny, yellowish green.

Goodyera oblongifolia (rattlesnake plantain).—Thick, dark green leaves are conspicuously veined and mottled with white. The flowering spike is greenish white.

Habenaria unalascensis (short-spurred rein orchid).—Leaves somewhat resemble those of *Clintonia* in early spring, but they are distinctly lined below and have hairless margins. Later, when the greenish spike of spurred flowers appears, the leaves wither.

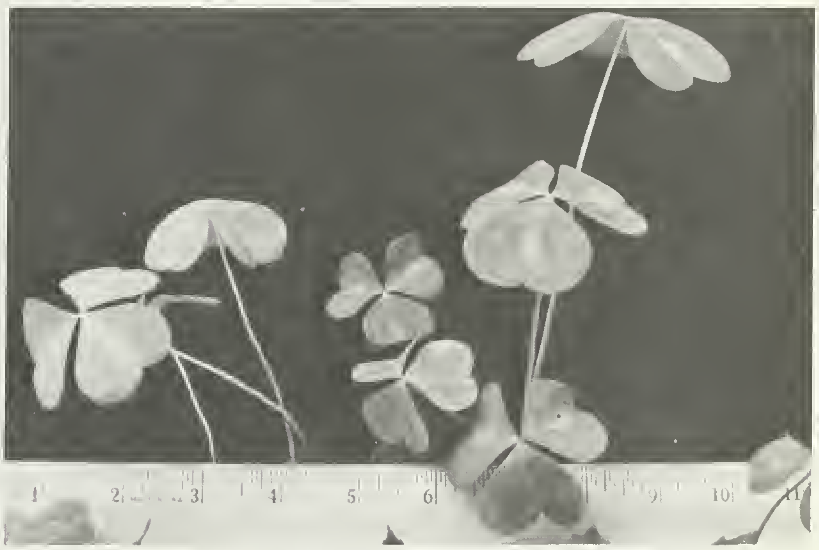
Ligusticum apiifolium (parsley-leaved lovage).—Compound basal leaves are cleft and dissected. The small, white flowers are clustered in umbels.



Lonicera hispidula (hairy honeysuckle).—A vine or climbing shrub with hairy, opposite leaves. It seldom blooms.

Montia sibirica (miner's lettuce).—Basal leaves long-petioled, stem leaves sessile. Flowers white or pink with rose-colored stripes and notched petals.

Osmorhiza chilensis (western sweet cicely).—Leaves are compound, each consisting of groups of three leaflets. The flowers are tiny, greenish white.



Oxalis sp. (oxalis).—Leaves are cloverlike.

Pachystima myrsinites (Oregon boxwood).—A low shrub with glossy, tooth-margined leaves. Flowers are green and red, very small and inconspicuous.

Psoralea physodes (California tea).—A shrubby herb with leaves in threes. Flowers are dull greenish white.

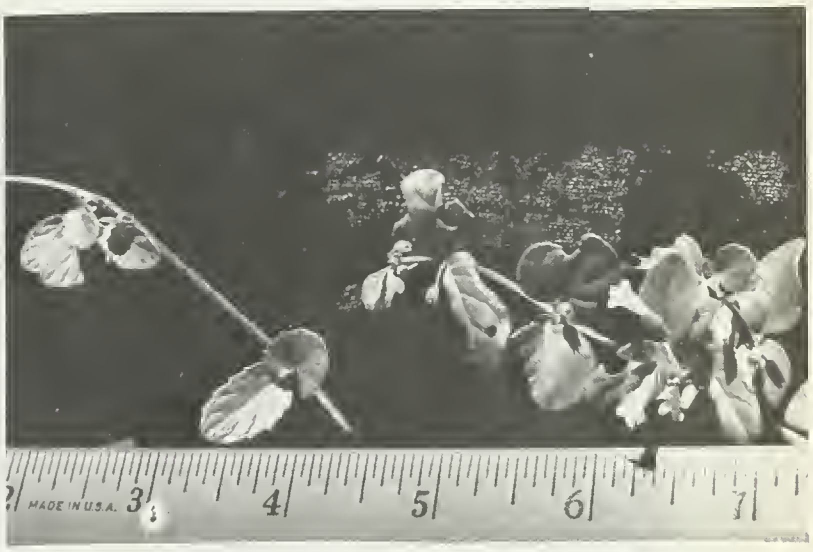
Pyrola picta (white-veined wintergreen).—The dark green, dull leaves are marbled with white along the veins above. They are unmarbled and often purple-tinged below. Flowers are yellowish- or greenish-white.

Quercus chrysolepis (canyon oak).—An often shrubby tree. The evergreen leaves are rigid and spiny (as shown) or rigid and smooth-margined. Both leaf types often occur on the same tree.

Quercus garryana (Oregon oak).—Leaf margins are rounded and without bristles.

Quercus kelloggii (California black oak).—Leaf margins are bristle-tipped.

Rubus nivalis (snow bramble).—A trailing vine with very glossy leaves and curved prickles. Flowers are dull purple, inconspicuous.



Satureja douglasii (yerba buena).—A prostrate herb with slender, trailing stems. The leaves have a strong, medicinal odor when crushed. Flowers are white or pink.

Smilacina racemosa (false Solomon's seal).—The unbranched stem is quite large. Numerous white flowers are borne in a dense terminal cluster.

Smilacina stellata (few-flowered false Solomon's seal).—The unbranched stem is quite small. A few white flowers are borne in a loose terminal group.

Tiarella unifoliata (western coolwort).—Leaves are simple, three- to five-lobed. Flowers are white.

Trillium ovatum (western trillium).—Leaves are borne in a whorl of three. The flower is white, turns purplish red with age.

Vaccinium membranaceum (thin-leaved huckleberry).—A shrub. The leaf margins are very finely toothed. Flowers are greenish white, berries purplish black.

Vaccinium parvifolium (red huckleberry).—A shrub. The green branches are sharply angled. Leaves have smooth margins. Flowers are pink, berries bright red.

Valeriana sitchensis (northern valerian).—Leaves are compound, opposite, and wavy-margined. Stems are hollow. Flowers are white or pink.

APPENDIX II

CLASSIFICATION PROCEDURE

I. Determine elevation class:

Below 2,500 feet = low elevation
2,500 to 4,000 feet = middle elevation
Above 4,000 feet = high elevation

II. Determine temperature and moisture classes:

A. Record the presence of all indicator plants by circling their point values on the tally sheet (Appendix III).

B. Calculate a temperature index by averaging the circled temperature values, then use this index to determine the temperature class:

8.0 and above = hot
6.5 to 7.9 = warm
4.1 to 6.4 = cool
4.0 and below = cold

C. Calculate a moisture index by averaging the circled moisture values, then use this index to determine the moisture class:

Above 8.0 = moist
4.0 to 8.0 = dry
Below 4.0 = very dry

III. Determine potential solar radiation class:

A. Measure slope and aspect with hand level and compass.

B. Look up the radiation index in table 1, then use this index to determine the radiation class:

Below 0.420 = low
0.420 to 0.520 = moderate
Above 0.520 = high

IV. Dig one or more soil pits at least 3 feet deep and determine soil series with the key in Appendix IV.

V. Describe the environment in a single phrase or series of abbreviations.

Example: Middle-elevation, warm, dry, high-radiation environment with Coyote soil (M, Wm, Dy, h - Co).

APPENDIX III

VEGETATION TALLY SHEET

Vegetation tally sheet for determining South Umpqua temperature and moisture indexes. To use, circle the values opposite each species present.

Species[1]	Temperature value	Moisture value
Abies magnifica var. *shastensis* (Shasta red fir)	1	--
Actaea rubra (western baneberry)	1	--
Adenocaulon bicolor (trail plant)	--	10
Amelanchier alnifolia (western serviceberry)	--	10
Anemone deltoidea (western white anemone)	4	15
Arbutus menziesii (madrone)	8	--
Arctostaphylos canescens (hoary manzanita)	4	10
Arnica cordifolia (heart-leaved arnica)	4	10
Berberis aquifolium (Oregon grape)	12	5
Berberis nervosa (long-leaved Oregon grape)	--	10
Castanopsis chrysophylla (chinquapin)	--	10
Ceanothus integerrimus (deerbrush)	--	10
Clintonia uniflora (queencup)	--	15
Corallorhiza maculata (spotted coralroot)	--	10
Cornus nuttallii (western flowering dogwood)	4	10
Cynoglossum grande (great houndstongue)	8	--
Disporum hookeri (Hooker's fairybells)	4	--
Festuca californica (California fescue)	8	5
Galium oreganum (Oregon bedstraw)	1	--
Gaultheria shallon (salal)	12	10
Goodyera oblongifolia (rattlesnake plantain)	4	--
Habenaria unalascensis (short-spurred rein orchid)	4	--
Ligusticum apiifolium (parsley-leaved lovage)	4	--
Lonicera hispidula (hairy honeysuckle)	12	1
Montia sibirica (miner's lettuce)	4	--
Osmorhiza chilensis (western sweet cicely)	--	10
Pachystima myrsinites (Oregon boxwood)	4	--
Pinus ponderosa (ponderosa pine)	4	5
Psoralea physodes (California tea)	--	10
Pyrola picta (white-veined wintergreen)	4	10
Quercus chrysolepis (canyon oak)	8	--
Quercus kelloggii (California black oak)	8	--
Rhododendron macrophyllum (western rhododendron)	--	15
Rhus diversiloba (poison oak)	12	1
Rubus nivalis (snow bramble)	--	15
Satureja douglasii (yerba buena)	12	--
Smilacina stellata (few-flowered false Solomon's seal)	--	15
Taxus brevifolia (western yew)	4	--
Thuja plicata (western redcedar)	4	15
Tiarella unifoliata (western coolwort)	1	--
Tsuga heterophylla (western hemlock)	4	15
Vaccinium parvifolium (red huckleberry)	--	10
Valeriana sitchensis (northern valerian)	1	--
Xerophyllum tenax (beargrass)	4	--
	____	____

[1] Nomenclature follows Hitchcock et al. (1955-69) and Peck (1961).

	Temperature value	Moisture value
Total, circled values	______	______
Number of species circled	______	______
Index*	______	______

$$*\text{Index} = \frac{\text{Total circled values}}{\text{Number of species circled}}$$

FOR TEMPERATURE:

Index	Class
8.0 and above	Hot
6.5 to 7.9	Warm
4.1 to 6.4	Cool
4.0 and below	Cold

FOR MOISTURE:

Index	Class
Above 8.0	Moist
4.0 to 8.0	Dry
Below 4.0	Very dry

APPENDIX IV

FIELD KEY TO SOUTH UMPQUA SOIL SERIES

This key is based on field observations and the soil series descriptions listed in an unpublished inservice report of the South Umpqua Soil Survey, USDA Forest Service, 1961.

1. Red or reddish brown throughout profile 2
1. Not red or reddish brown throughout 5

2. Shallow, with many stones in top 2 feet and stone content increasing with depth 3
2. Deep, with very few stones in top 2 feet or with stone content decreasing with depth 4

3. Gravelly clay loam subsoil, sticky when wet . . . . Coyote Series
3. Gravelly loam subsoil, not sticky . . . . Straight Series

4. Clay subsoil . . . . Dumont Series
4. Clay loam subsoil . . . . Freezeout Series

5. Top 18 inches of profile uniformly very dark brown or black and homogeneous. Above 3,000 feet 6
5. Top 18 inches of profile not uniformly very dark brown or black 7

6. Entire profile very dark brown or black. Top 18 inches of profile stony . . . . Hummingbird Series
6. Lower profile yellowish brown. Top 18 inches of profile not stony . . . . Snowbird Series

7. Clay loam or clay subsoil, usually sticky 14
7. Loam or sand subsoil, seldom sticky 8

8. Flourlike pumice throughout profile. No gravel or stones . . . . Crater Lake Series
8. Not flourlike, gravel or stones present 9

9. Gravelly, but without stones larger than 3 inches in diameter. Stream bottoms, stream terraces, and alluvial fans . . . . Alluvium
9. Gravel absent or stones larger than 3 inches in diameter present 10

10. Shallow, with many stones in top 2 feet and stone content increasing with depth 12
10. Deep, with very few stones in top 2 feet or with stone content decreasing with depth 11

11. Soft, loose subsoil. Dark-colored parent rocks . . . . Boze Series
11. Slightly hard, coherent subsoil. Light-colored parent rocks . . . . Acker Series

12. Subsoil greenish or olive brown. Parent rocks green . . . . Deadman Series
12. Subsoil brown, yellowish brown, or grayish brown 13

13. Yellowish brown subsoil. Dark-colored parent rocks . . . . Prong Series
13. Brown or grayish brown subsoil. Light-colored parent rocks . . . . Vena Series

14. Shallow, with many stones in top 2 feet and stone content increasing with depth. Clay loam subsoil. . . . . Deadman Series
14. Deep, with very few stones in top 2 feet or with stone content decreasing with depth. Sticky clay subsoil 15

15. Subsoil mottled 16
15. Subsoil not mottled 18

16. Mottling above shallowest sticky clay horizon . . . . Tallow Series
16. Mottling within sticky clay horizon, not above 17

17. Top 6 inches of clay horizon grayish brown mottled with dark brown. Light-colored parent rocks . . . . Gustin Series
17. Top 6 inches of clay horizon light olive brown, unmottled (mottling is lower in horizon). Dark-colored parent rocks . . . . Zinc Series

18. Light olive brown to greenish brown clay horizon. Parent rocks green . . . . Fivesticks Series
18. Brown to dark brown clay horizon. Parent rocks dark-colored but not green. . . . . Bullock Series

☆GPO—795-653

Minore, Don
1972. A classification of forest environments in the South Umpqua basin. USDA Forest Serv. Res. Pap. PNW-129, 28 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

A classification of forest environments by elevation, temperature, moisture, potential solar radiation, and soil type is described. It facilitates comparisons of forested areas--comparisons that eventually should make it possible to prescribe optimal management practices for every forest environment in the South Umpqua basin.

Keywords: Classification, environment, indicator plants, temperature, moisture, solar radiation, soil series.

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The mission of the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is to provide the knowledge, technology, and alternatives for present and future protection, management, and use of forest, range, and related environments.

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1. Providing safe and efficient technology for inventory, protection, and use of resources.
2. Development and evaluation of alternative methods and levels of resource management.
3. Achievement of optimum sustained resource productivity consistent with maintaining a high quality forest environment.

The area of research encompasses Oregon, Washington, Alaska, and, in some cases, California, Hawaii, the Western States, and the Nation. Results of the research will be made available promptly. Project headquarters are at:

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